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Research article

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Posttraumatic Stress Disorder in patients with traumatic brain injury

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Abstract

Background: Severe traumatic stressors such as war, rape, or life-threatening accidents can result in a debilitating psychopathological development conceptualised as Posttraumatic Stress Disorder (PTSD). Pathological memory formation during an alarm response may set the precondition for PTSD to occur. If true, a lack of memory formation by extended unconsciousness in the course of the traumatic experience should preclude PTSD.

Methods: 46 patients from a neurological rehabilitation clinic were examined by means of questionnaires and structured clinical interviews. All patients had suffered a TBI due to an accident, but varied with respect to falling unconscious during the traumatic event.

Results: 27% of the sub-sample who were not unconscious for an extended period but only 3% (1 of 31 patients) who were unconscious for more than 12 hours as a result of the accident were diagnosed as having current PTSD ($P < .02$). Furthermore, intrusive memories proved to be far more frequent in patients who had not been unconscious. This was also the case for other re-experiencing symptoms and for psychological distress and physiological reactivity to reminders of the traumatic event.

Conclusion: TBI and PTSD are not mutually exclusive. However, victims of accidents are unlikely to develop a PTSD if the impact to the head had resulted in an extended period of unconsciousness.

Background

Introduction

Posttraumatic Stress Disorder (PTSD) may result from psychological trauma, i.e. highly stressful experiences such as rape, severe accidents or war experiences that elicit an extreme alarm response. In the course of the accident, a blow to the head can be so severe that the victim falls unconscious and memory formation becomes inter-

rupted. It is currently not sufficiently known how neurological trauma, resulting in traumatic brain injury (TBI) exactly interferes with the emergence of PTSD. The present study aims to contribute to the resolve of the previously contradictory study outcomes by clarifying the role of unconsciousness.

Characteristics of PTSD in connection with TBI

Loss of consciousness and amnesia

Joseph and Masterson [1] define traumatic brain injury as a consequence of a collision of an individual's head with another object causing brain tissue damage through violent impact and twisting. TBI is very often accompanied by loss of consciousness that can vary substantially in its duration. According to Bryant [2], this is the most salient feature of TBI and it plays a major role in the controversy over the coexistence of PTSD and TBI. Given that pathological memory formation is a prerequisite for PTSD [3], it has been argued that loss of consciousness prevents the formation of the traumatic memory constellation. Thus, PTSD and TBI might be mutually exclusive [4,5]. Consequently, it has been claimed that loss of consciousness may even have a protective effect with regard to the development of PTSD [6]. On the other hand, several authors have described PTSD caused by events that also resulted in TBI [1,7,8]. Unfortunately, most previous studies did not examine TBI patients who fell profoundly unconscious separately from those who remained conscious or were unconscious for only a brief period of time.

Symptoms of reexperiencing in patients with TBI

Reexperiencing symptoms are a main feature of PTSD. One important issue in the question of whether TBI and PTSD can be caused by the same event is the form that reexperiencing symptoms take in patients who have no recollection of the actual event. It is possible that the criteria for reexperiencing are being met because the symptoms "intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event" or "physiological reactivity on exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event" [9] are present. This would also be possible even if there is no actual recollection of the traumatic event itself.

Apart from this explanation, intrusions and nightmares may well contain content other than that directly related to the event itself. For example, there may be memories of being in the ambulance, waiting in the emergency room, or waking up in hospital. There may also be so-called "islands of memory" such as hearing cries of other people or feeling close to death. Sometimes gaps in memory are even filled in with a reconstruction or fabrication of events that occurred during the most stressful moments. Thus, it is possible that patients recover memories of events for which they were previously amnesic. These reconstructions and fabrications might then in turn become the content of intrusions or nightmares

Severity of TBI

There are two ways in which the severity of the TBI may influence the likelihood of the formation of PTSD. On the

one hand, it might be argued that the more severe the TBI, the more severe the accident and, thus, the more likely PTSD is to occur. Indeed, it has been found that the nature of the traumatic event and the development of PTSD are related. However, when only victims of traffic accidents are taken into consideration, there doesn't seem to be a direct relationship between characteristics of the accident and the likelihood of the development of a PTSD [10]. On the other hand, a more severe TBI is more often followed by loss of consciousness and amnesia. As described, the loss of memory can serve as a protective agent against the formation of PTSD. This is in accordance with findings from McMillan [8] who came to the conclusion that severe TBI was less often followed by PTSD.

The problem of overlapping symptoms in PTSD and TBI

PTSD and TBI have several symptoms in common. Among these are irritability, concentration deficits, amnesia for the causal event, reduced cognitive processing ability [11], and sleeping disturbances [8]. This adds to the difficulty in diagnosing PTSD in patients with TBI.

Research Questions

Incidence of PTSD in patients with TBI

It is expected it is possible for PTSD to occur in patients who have sustained a traumatic brain injury. However, due to potential post-traumatic amnesia, PTSD should occur more rarely in TBI patients than in persons who have undergone other kinds of traumatic experiences. The prevalence rates in other groups of patients range from 16.5% for motor vehicle accidents [12] to near 50% after rape [13] but may reach near 100% in those who have undergone multiple and repeated severe traumatic stressors [14].

Within the group of patients who have sustained a traumatic brain injury, it is expected that PTSD will occur less frequently in those who have lost consciousness for more than 12 hours than in those who were not unconscious at all, or who were unconscious for less than one hour.

Forms of reexperiencing

It is expected that intrusive memories and nightmares will be more frequent in patients who did not lose consciousness during the event. In addition, it is assumed that reexperiencing symptoms will be different and occur at different rates in patients who have no recollection of the event itself. More specifically, it is hypothesized that the intrusive memories of patients with no memory of the event will relate to events that occurred shortly before or after the accident rather than memories related to the accident itself. The way in which the traumatic stress episode is re-experienced should thus differ depending on the amount or type of memory loss.

Methods

Participants

Inpatients from a neurological rehabilitation unit were included in the study if they had suffered from a traumatic brain injury or from a traumatic injury to the cervical spine within the last five years. All patients who fulfilled these criteria and who were newly admitted to the rehabilitation unit over a period of four months were invited to participate in the study. Only three out of 49 patients who had been asked refused to participate. Informed consent was obtained from 46 inpatients (14 female) aged between 19 and 58 years (mean 37.5 ± 10.7 years). In the sample, between one to 82 months had passed since the injury. Patients were divided into two groups: one group had experienced loss of consciousness for at least 12 hours ($N = 31$); for the remaining 15 participants injury there was no loss of consciousness ($N = 9$) or there was a loss of consciousness between several minutes to 1 hour ($N = 6$). The gap in the distribution between the group with "no loss to less than one hour", and the group with "12 hours or more" appeared without any pre-selection. Consequently, it was not necessary to exclude patients from the analysis to obtain this bimodal distribution. Loss of consciousness was determined both through patients self recollection and through medical record whereby the two sources of information were congruent for all cases.

Measures

Sociodemographic variables

Sociodemographic variables including age, occupation, and family status were initially obtained from the admission report and completed by means of an in-person interview. All participants were then asked to report in detail the course of events that had led to the accident, using their own recollection or – if amnesic for the accident – reiterating information they had gathered from various sources about the event.

Subtest 6 of the Wechsler Memory Scale

The subtest 6 of the Wechsler Memory Scale [15] was used as a rough indicator of memory functioning.

Abbreviated Injury Scale (AIS)

The severity of the injury sustained from the accident was measured using the Abbreviated Injury Scale (AIS) [16]. Through the AIS, the Injury Severity Score (ISS) can be obtained. The highest ISS score obtainable is 75. Another indicator of the severity of injury is the so called LD_{50} . It is defined as a severity of injury that results in death for 50% of the patients injured. The LD_{50} is an ISS of 40 for ages 15–44, 29 for ages 45–64, and 20 for ages 65 years and older.

Posttraumatic Diagnostic Scale (PDS)

The PDS by Foa [17] was used in order to assess the symptom severity and differences between the several symptom groups.

Hopkins Symptoms Checklist (HSCL)

Measures of anxiety and depression were obtained through the HSCL [18].

SCID (PTSD Section)

PTSD was assessed using the respective section of the SCID (German version) [19]. In each case – including those which did not reach DSM-criteria for PTSD – all items were presented in order to obtain a measure of symptom severity.

Interview on intrusive memories

Based on the goal to investigate the content of intrusive memories in TBI patients, a set of interview items were compiled. These items indicated content, senses affected, relevant time frame and frequency of intrusive memories. Patients were asked explicitly to report the following: 1) the last memory before loss of consciousness, 2) the process of waking up from unconsciousness, 3) how they found out about what happened during the accident, and 4) whether they had suffered stressful or upsetting experiences during their hospital stay. The presence of intrusive memories was assessed, as was the frequency of these intrusions and how upsetting they were. Only those patients who actually suffered from intrusions answered the more specific questions pertaining to content, mode of sense, relevant space of time, and frequency of intrusive memories. Some of the items were adopted from Steil [10]; others were based on our own clinical experience.

Procedure

Patients were assessed in two sessions on two different days within one week. During the first session, sociodemographic information was obtained as was information about the nature of the accident, and the severity of injuries. Questionnaires were also completed by the participants in this first session. During the second session, the PTSD section of the SCID and an interview on intrusive memories were administered.

Results

Characteristics of the two groups

Characteristics of the two groups are presented in Table 1. Five (10,9%) of the total sample of 46 patients were diagnosed with PTSD (one female). Only one out of the five PTSD-patients had been unconscious at the time of the accident, all the others had been conscious. Table 1 also shows the proportion of PTSD for the two groups. The difference is significant ($P < .05$) according to Fisher's exact P-value.

Table 1: Characteristics for the two groups (loss of consciousness for more than 12 hours or less than one hour).

	group con (N = 15)	group uncon (N = 31)	statistical difference
Age	41.2	35.7	n.s.
WMS-6 (mean of percentile rank)	35.9	45.8	n.s.
Severity of injury (AIS)	11.0	21.3	P = .002 (Mann-Whitney-U = 103)
Reexperiencing symptoms (PDS Score)	6.53	2.46	P = .005 (Mann-Whitney-U = 101)
Avoidance symptoms (PDS)	6.53	6.3	n.s.
Arousal symptoms (PDS)	6.33	5.3	n.s.
HSCL anxiety	2.15	1.67	P = .03 (Mann-Whitney-U = 138)
HSCL depression	1.77	1.74	n.s.
Proportion PTSD (SCID)	26.7% (N = 4)	3.2% (N = 1)	P = .017 (Chi-Sq. = 5.733)
Occurrence of intrusions	66.7% (N = 10)	25.8% (N = 8)	P = .008 (Chi-Sq. = 7.086)

In order to test whether the significantly higher proportion of PTSD in the patients who had been conscious at the time of the accident was due to other characteristics, the two groups, "conscious" vs. "unconscious", were compared with regard to severity of injury, as measured through the Abbreviated Injury Scale. The Mann-Whitney-U-Tests were conducted to test for differences between the groups. The difference was significant, but severity of injury was even higher in the group of patients who had been unconscious.

Intrusions

Ten patients (10 out of 15, i.e. 66.7%) who had been conscious and eight patients (8 out of 31, i.e. 25.8%) who had been unconscious suffered from intrusions. The difference in relative frequencies is significant (table 1). For these two groups, the results from the structured interview on intrusive memories was compared using Mann-Whitney-U-Tests (table 2). Table 2 is divided into two sections: Those variables in which higher values were expected for the group "conscious" are shown in the first section, those variables in which higher values were expected for the group "unconscious" are shown in the second section. All significant differences were in the expected direction.

Table 2: Frequency and quality of intrusions depending on consciousness

	patients with intrusions °				
	conscious (N = 10)		unconscious (N = 8)		U
	Mean	Rank sum	Mean	Rank sum	
Frequency of intrusions during the last week	5.95	120	3.25	51	15*
Intrusions of the accident itself	3.3	115.5	2.0	55.5	19.5*
Visual intrusions	3.3	104.5	2.75	66.5	30.5
Acoustic intrusions	2.7	113.5	1.38	57.5	21.5
Olfactory intrusions	1.0	95	1.0	76	40
Bodily sensations during intrusions	2.7	119	1.0	52	16**
Same feelings as during the event	2.9	123	1.0	48	12**
Impression that event is happening at this moment	2.3	115	1.0	56	20*
Internal narrative about the sequence of events	1.0	67.5	1.63	85.5	22.5*
Intrusions of the space of time before the accident	1.7	97.5	1.5	73.5	37.5
Intrusions of the space of time after the accident	2.4	86.5	2.57	66.5	31.5
Intrusions about reports by others	1.3	79.5	2.38	91.5	24.5
Intrusions based on imaginations	1.4	97.5	1.38	73.5	37.5
Ruminations without an image of the event	1.78	90.5	1.38	62.5	26.5

° Only those were included in the analysis. * $p \leq 0.05$; ** $p < 0.01$. Note: "Frequency" is the number of intrusions during the last week. All the other variables were coded from 1 to 4, with 1 = never, 2 = seldom, 3 = often, 4 = always.

Discussion

Central to the present study is the question of how the development of PTSD in patients with TBI is influenced by extended loss of consciousness. In order to investigate this, two groups of patients were formed and compared. The first group consisted of people who had either not lost consciousness during the event or were unconscious for less than one hour. This group was compared to a sample of those who had lost consciousness for twelve hours or more. It was assumed that in cases in which unconsciousness lasted less than 1 hour there would still be sufficient islands of memory of the accident itself. According to reports of the participants in the present study, this assumption proved to be correct. In order to ensure that differences in the incidence of PTSD symptoms were not due to other characteristics, the two groups were also compared with regard to age at the time of the accident, current memory functioning, and severity of injury. The groups did not differ significantly with regard to age or memory functioning as indicated through the WMS-6. There was a significant difference in severity of injury as measured through the AIS: those patients who had experienced loss of consciousness sustained more severe injuries. Since this group was less likely to develop PTSD, severity of injury did not prove to be a contributing factor.

Incidence of PTSD in patients with TBI

Of the sub-sample of patients with extended unconsciousness, 3 % were diagnosed with PTSD. This is considerably lower than the prevalence rates for other traumatic experiences where victims remained conscious, including traffic accidents (16.5 % according to Ehlers et al. [12]), war crimes (22% [14]), rape (50 %) and other forms of assault (25 % [13]). It is also below the 5% (men) or 10% (women) lifetime prevalence for PTSD in the USA [20]. In contrast, the 27% point-prevalence in the TBI-group without extended unconsciousness corresponds well with the typical point-prevalence after traumatic stress experience in other studies.

However, in this sample it has been shown that PTSD does indeed occur in patients who have sustained a traumatic brain injury. The two disorders are not mutually exclusive. However, PTSD occurs less frequently than in patients who have suffered more severe types of traumatic events. The duration of unconsciousness explains the variance and the low occurrence rates. Obviously, loss of consciousness has a protective effect with regard to the development of PTSD. Larger sample sizes would be needed to determine if loss of consciousness consistently prevents the development of PTSD.

Finally, it is of great importance for the clinician to be aware of the possibility of the development of PTSD, especially in patients who did not sustain severe organic brain

damage. In certain cases, psychologically related symptoms may be erroneously attributed to organic causes.

Forms of reexperiencing

It has also been shown in this study that intrusive memories and nightmares occurred more often in patients who had not lost consciousness during the event. Intrusions in these patients related more to the accident itself, rather than to events occurring shortly before or after the accident. Finally, these patients were more likely to report re-experiencing bodily sensations and feelings similar to those during the accident, as well reporting times in which they had the impression that the event is still occurring in the present. On the other hand, patients who had lost consciousness during the event were more likely to report experiencing an internal narrative of the event. This was never the case in patients who had been conscious. Thus, it could be shown that loss of consciousness has an influence on the frequency and the form of intrusive memories.

There was no support for the assumption that patients who had been unconscious at the time of the accident would experience more intrusions of the events occurring before or after the accident. While this did happen, it was not more frequent than in patients who had been conscious. As hypothesized, intrusions through reports from others were more frequent in patients who had sustained loss of consciousness. However, this difference was not significant.

Comorbidity

Patients who had been diagnosed with PTSD also scored high on measures of anxiety and depression using the HSCL. This corresponds to findings from other studies which have found a high degree of comorbidity for these disorders [21].

The two groups of patients (conscious – unconscious) did not differ with regard to level of depression. However, there was a significant difference in the scores that indicated anxiety symptoms, with the "conscious" group scoring significantly higher on measures of anxiety than the "unconscious" group. Apparently, conscious processing or memory of the event is required for the development of both anxiety symptoms and PTSD. Given the many causes of depressive symptoms, the lack of significant differences between groups comes as no surprise with the present sample size.

Limitations of the study

All patients from the present study were inpatients of a neurological rehabilitation unit. Thus, the findings may not be representative of other patients who have suffered from a TBI. Generally, patients still had neurological

problems or physical handicaps, which may explain their vulnerability to the development of psychopathology. This, however, is contrasted by the lack of PTSD after severe loss of consciousness. It should also be noted that due to the nature of this study, there is no proof for causality, i.e. it may not be the loss of consciousness that prevents PTSD but some other factor that may be related to both a PTSD-resilience as well as a vulnerability to falling unconscious.

Conclusions

While findings of the present study show that PTSD may occur in patients with TBI, it seems that only those patients who remained conscious during the accident are at risk for development of the psychopathological disorder. Loss of consciousness seems to play a protective role with respect to PTSD-development.

Competing interests

None declared.

Authors' contributions

All authors participated in the design of the study. FN and JG composed the set of instruments. JG and RL collected the data. JG and FN performed the data analysis. JG drafted and FN and TE revised the manuscript. All authors read and approved the final manuscript.

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